ONTARIO

Underdrained Filter Systems
Whitby Experimental Station

Interim Report – Part 2

1973

INTERIM REPORT

ON

UNDERDRAINED FILTER SYSTEMS

AT

WHITBY EXPERIMENTAL STATION

PART II

By

N.A. CHOWDHRY, P. Eng.

Private Waste & Water Management Branch

Ministry of the Environment

1973

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SUMMARY OF

INTERIM REPORT

PART I

(PUBLISHED SEPTEMBER, 1972)

As a program of the Technical Services Section, Private Waste and Water Management Branch, six underdrained filter beds were put in operation at the Ontario Hospital, Whitby, Ontario. These have been tested continuously since September 1969 by dosing them with septic tank effleunt obtained from domestic sewage originating in the Hospital Staff quarters.

Interim report Part I dealt with pilot plant study of the treatment of septic tank effluent by filtering it through 30 inches (76 cm)* of commonly available sand with different effective grain sizes (D_{10}) 0.15 to 2.5 mm and different uniformity coefficients (C_u) 1.2 to 4.4, for a period of 9 months between September 1969 and July 1970. The filter bed loading rate of sewage was approximately 1 gal./sq. ft./day, (49 litre/m^2/day)as a trickle flow effluent discharged from a conventional septic tank through perforated 4 inch (10 cm) diameter No-corrode or ABS pipes.

The final effluent from the filter beds had analyses for BOD and Suspended Solids in the range of 3.0 to 6.0 mg/l and 1.0 to 3.0 mg/l, respectively, for 50% of the time and both under 10.0 mg/l for 85% of the operating time.

* The conversion into metric units is approximate.

The useful life of beds containing filter media of D_{10} = 0.15 mm and 0.19 mm was limited to only four months at the above sewage load. The large grain filter media of D_{10} = 2.5 mm treated the sewage well enough to result in an effluent which is suitable for discharging into a water course.

The stabilization of nitrogen compounds to nitrates as well as the complete oxidation of free ammonia took relatively longer time for commencement of the treatment processes as compared with BOD, COD, Suspended Solids, etc., which attained low values within 2-5 days from the starting up of the operation.

Very wide fluctuations in the total and fecal Coliforms in the effluents of the weekly samples from all the beds were observed. The bacterial count in the effluents, when considered in 85% of the samples through sands of D_{10} = 1.0 m and 2.5 mm was relatively higher than that in the effluent through finer media with D_{10} less than 1.0 mm.

The water usage in the houses was in the range of 20.0 gal./capita/day (91 l/capita/day) to 42.0 gal./capita/day (191 l/capita/day). The average usage in the community was 31.4 gal./capita/day (143 l/capita/day).

INTERIM REPORT

PART II

ABSTRACT

This report (2nd Interim) deals with the study regarding treatment of domestic waste by filtering through sands of different physical characteristics i.e. effective sizes and uniformity coefficient, for a period of 9 months between July, 1970 and March, 1971.

The filter media in the two beds, which had clogged (Interim Report Part I, p.7) was replaced by sand with D_{10} = 0.24 mm and C_u = 3.9.

One of these beds contained an 8 inch (20 cm) layer of sand mixed with "red mud" from Alcan for phosphate removal.

Four of the beds with sand in the range of D_{10} = 0.3 to 2.5 mm operated for over 1½ years; and two other beds with replaced media, operated for 9 months. None of these beds caused any clogging problems.

These beds received septic tank effluent showing for 85% of time BOD values, 310.0 mg/l and Suspended solids values 153 mg/l or less. The corresponding treated effluent had values for BOD in the range of 4.3 to 9.5 mg/l and Suspended Solids 1.5 to 7.6 mg/l.

There appeared to be further oxidation of nitrogen compounds indicated by very low free ammonia and relatively high nitrate content.

There was a slight reduction in phosphate by the treatment through sand. The septic tank effluent had 85% of the total phosphate (PO_4) values equal to or less than 66.0 mg/l and the treated effluent had phosphate (PO_4) in the range of 44.0 to 58.0 mg/l in 85% of the samples.

The bed containing Alcan "red mud" (Oxides of Al, Fe and Ca) reduced the phosphate (PO_4) content appreciably. The values for 85% of the time were 7.5 mg/l or less as compared to that of 66.0 mg/l in septic tank effluent.

The water usage during the period in the houses was in the range of 24.5 gal. (110 litre) to 41.0 gal. (187 litre) per capita per day. The average usage in the community was 38.8 gal. (177 litre) per capita per day.

INTRODUCTION

The study on the treatment of water carried household waste by sand filters was started in September, 1969 and has been continued. The location of the experimental facilities, description of the installation, details of the plant and operation of the system for initial nine months periods up to June, 1970, has been presented in Interim Report Part I. Plant drawings are shown in Appendix II of this report.

The filter beds No.2, 3, 5 and 6, since installation have been in use continuously. The beds No.1 and 4 containing sands with effective sizes of 0.19 mm and 0.15 mm, respectively, which however had clogged after about four months operation, were shut down and the sand replaced. The filter media characteristics for the six beds, as in operation, are shown in the following table.

	Bed No.	D_{10} mm	C_u	"k" cm/sec
Medium Sand (with "Red Mud")	1	0.24	3.9	2.6×10^{-2}
Block Sand	2	0.30	4.1	9.0×10^{-2}
Foundry Slag	3	0.60	2.7	3.36×10^{-1}
Medium Sand (without "Red Mud")	4	0.24	3.9	2.6×10^{-2}
Fine Gravel with Sand	5	1.00	2.1	9.6×10^{-1}
$\frac{1}{4}$" Gravel	6	2.50	1.2	4.84

OPERATION

The beds No.1 and 4 which had clogged as reported (Interim Report Part I) were shut down on July 23, 1970, and dug out. There was a deposit of black slimy material on the gravel and sand in both beds. The interface apparently had an impervious film resulting in ponding of the waste.

Filter media in beds No.1 and 4 were replaced by sand with effective size of 0.24 mm, uniformity coefficient 3.9. A portion of the sand in bed No.1 had been mixed with "red mud" obtained from Alcans mining operators in P.Q. The filter box No.4 however, was filled with the sand without "red mud" to act as a control. On July 27, 1970, both beds No.1 and 4 were started with a feed rate of $\frac{1}{2}$ gal. per sq. ft. (24 l/m^2) of filter area per day. The rate was increased to 1 gal. per sq. ft. (49 l/m^2) of filter area per day from September 17, 1970. During the summer months, the amount of sewage collected was far less than the amount of water used as recorded on water meters. That was apparently due to the water used in the sprinklers for the gardens and also due to losing some water through possible cracks in the sewer line and the septic tank.

On December 10, 1970, after about two years operation, the septic tank was pumped out to remove sludge and scum.

During winter months, as before, the amount of sewage received from the houses was much greater than the water used. This apparently was due to the infiltration of ground water. Due to extremely low temperatures caused by the storm on February 27, 1971, some of the buckets and inlet pipes to the filter beds were frozen overnight. This problem however, did not last for long and was cleared during the following day.

The influent load to beds No.2 and 3 was increased from 1 gal. to $1\frac{1}{2}$ gal. per sq. ft. per day (49 to 73 l/m^2 per day) from October 26, 1970 and was maintained at that rate throughout the period under report. The other beds, for most of the time, operated at 1 gal. per sq. ft. per day.

The 24 hour composite samples of the effluent from the septic tank and the filter beds for chemical and bacteriological analyses were collected once a week. These indicators, as before, are BOD; COD; nitrogen as free ammonia, organic, nitrite and nitrate; phosphates (PO_4):total, ortho and poly; solids: suspended, volatile, and total; surfactants as ABS;and coliform: total and fecal. The analyses of one set of the samples is shown in Table 1.

Daily temperature, pH values and dissolved oxygen content have been recorded.

Observations for the amount of water used in the residences is given in Table 2.

Excepting bed No.4 which apparently has some leak at the bottom of the bed and thereby not returning all the final effluent to the measuring bucket, all the other beds have been operating without major problems during the period under report.

TREATMENT OF DATA

From the laboratory reports it is observed that most of the values had considerable variation from day to day. These values, when plotted on linear or logarithmic graphs, indicate the variations and limits of the values. Proper evaluation of the data cannot be made by mathematical averages of series of results. Consequently, the graphical method of C.J. Valz* was then used to treat the data as follows:

(a) The data was arranged in order of ascending magnitude.

* C. J. Valz, WATER AND SEWAGE WORKS Vol.98, p.66-73, 1951

(b) A serial number "m" was assigned to each of the "n" values 1, 2, 3,.....n.

(c) The plotting position of each serial number, giving the probability equal to or less than each value, was determined by the ratio $\frac{m}{n+1}$ expressed as a percentage by multiplying by 100.

(d) The points were then plotted on logarithmic probability paper. Generally, a straight line developed in the plotting which confirmed that the data were logarithmically normal.

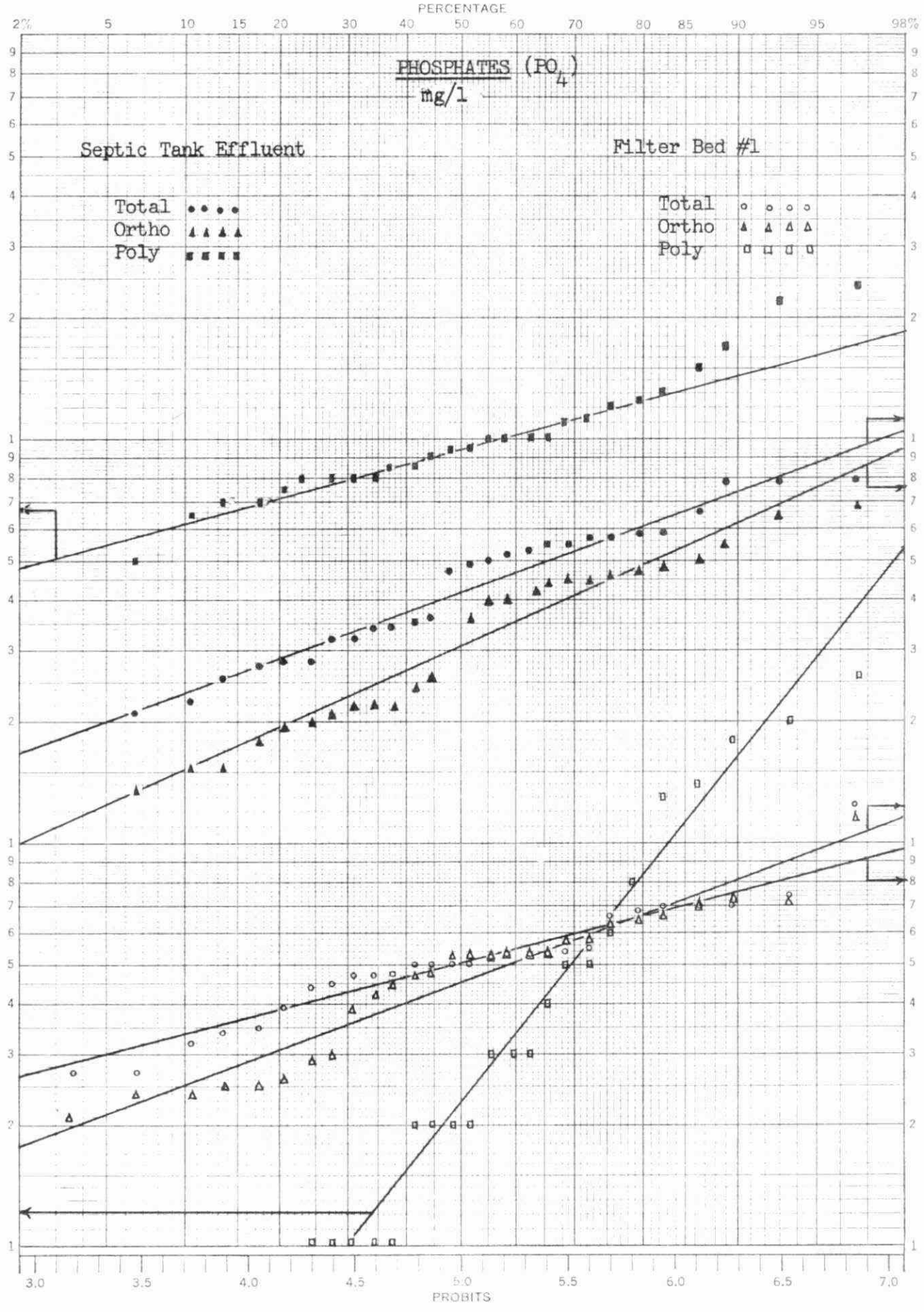
The 15%, 50% and 85% of the time values for each parameter were taken from the graph (graph 1 is representative) and tabulated for individual beds in Tables 3 to 8 and for septic tank effluent in Table 9.

FILTER BED NO.1 - D_{10} = 0.24 mm, C_u = 3.9 and "red mud"

Filter bed No.1 showed overflow of the waste, as reported earlier (Interim Report Part I).

The raw sewage feed was cut off for a few weeks to see if the resting period could assist in removing the clogging material. However, it was found that little improvement in the system could be made, consequently, the feed was completely shut-off on July 23, 1970, to dig out the filter sand. It was observed that a slimy material had coated the gravel and apparently a greyish black impervious layer at the interface was not allowing seepage of the waste through the filter.

GRAPH I



The filter material was removed. There was no clogging of the holes of the collector pipes.

The bed was refilled with a sand of effective size 0.24 mm and uniformity coefficient of 3.9. In addition, the sand had been mixed with "red mud" obtained from Alcan Co., Montreal, in a hand cement mixer to provide approximately 4% of "red mud" in the sand. This mixture was put on top of the 13 inches sand as a layer 8 inches deep on top of this again was the filter sand. The details of filter media as filled in the bed and the analyses (physical and chemical) of "red mud" is given in Appendix I.

The waste feed in the bed was started on July 29, 1971, at the rate of $\frac{1}{2}$ gal. per sq. ft. (24 l/m^2) per day. The rate was increased to 1 gal. per sq. ft. (49 l/m^2) per day on September 17, 1970. This rate was maintained throughout the period under report.

The values for the various parameters were plotted and the results for 15%, 50% and 85% of the times are shown in Table 3. The corresponding results for the septic tank effluent are shown in Table 9.

The filter media treated the waste to produce an effluent with BOD, COD and suspended solids for 85% of the time, equal to or less than 5.5, 39 and 1.5 mg/l respectively.

There was a considerable reduction in the total phosphate (PO_4) content, the respective values for 50% and 85% of the time being 5.0 and 7.3 mg/l or less.

The free ammonia (N) concentration in the effluent was 6.34 mg/l tested after four days of operation, but was reduced to 0.36 mg/l after two weeks. It was not detected in over 45% of the samples. The values

for 50% and 85% of the samples were equal to or less than 0.06 and 1.70 mg/l respectively. Only in three samples the values were 3.0 to 4.0 mg/l.

The nitrite (N) and nitrate (N) for 85% of the samples were equal to or less than 1.0 and 52.0 mg/l respectively.

The total and fecal coliform counts were 8,000 and 4,200/100 ml or less in 85% of the samples.

The ABS values for 50% and 85% of the samples were 0.47 and 0.79 mg/l respectively.

FILTER BED NO.2 -D_{10} = 0.3 mm, C_u = 4.1

The filter bed continued operating at 1 gal. per sq. ft. (49 l/m^2) per day till October 26, 1970, when the feed rate was increased to $1\frac{1}{2}$ gal. per sq. ft. (73 l/m^2) per day. There was no major problem with the system.

The concentration of the various indicators did not show any significant difference. The BOD values for 50% and 85% of the samples were equal to or less than 6.1 and 9.5 mg/l respectively. The corresponding values for the suspended solids were 1.0 and 3.5 mg/l. The volatile solids had always been less than 1.0 mg/l. The values for COD were in the range of 20 to 50 mg/l.

Total phosphates (PO_4) for 85% of samples were 44.0 mg/l or less and the corresponding value for ABS was 1.25 mg/l.

The concentration of free ammonia (N), nitrite (N) and nitrate (N) for 85% of the samples were 9.4, 0.70 and 39.0 mg/l or less, respectively. The corresponding values during the period of the first report had been 15.0, 0.6 and 28.0 mg/l There appears to be a decrease in free ammonia (N) and increase in Nitrate (N) content.

The total and fecal coliform counts were 110,000 and 60,000/100 ml respectively. In the previous report the corresponding values were 600,000 and 160,000/100 ml.

The values for the various indicators are shown in Table 4.

FILTER BED NO. 3 - D_{10} = 0.6 mm, C_u = 2.7

Filter bed No.3 continued operating without any major breakdown, in the system. The feed rate was increased from 1 gal. to $1\frac{1}{2}$ gal. per sq. ft. (49 to 73 l/m^2) per day effective October 26, 1970. There was no significant change in the values of the various parameters. These are shown in Table 5.

The BOD, COD and Suspended Solids during this period for 85% of the samples were 8.1, 59.0 and 2.4 mg/l or less, respectively.

The corresponding values in the previous report were 8.6, 51.0 and 3.5 mg/l. The values for free ammonia, nitrite and nitrate (N) were 8.0, 0.84 and 52.0 or less, respectively for 85% of the samples. In the previous report the respective values were 8.0, 1.9 and 40.0 mg/l.

The total phosphate (PO_4) and ABS were 54.0 and 1.2 mg/l respectively, as compared to 50.0 and 0.86 mg/l in the previous report.

The values of coliform counts for the period under review were equal to or less than $\leqslant$ 900,000 total coliforms/100 ml and 150,000 fecal coliforms/100 ml for 85% of samples as compared to 2,000,000 and 100,000/100 ml reported earlier.

FILTER BED NO. 4 - D_{10} = 0.24 mm, C_u = 3.9

The bed No. 4 had earlier shown signs of ponding and hence it was turned off onMay 4, 1970. The bed was dug out on July 25, 1970.

Since it had been shut down for 10 weeks the filter sand had all dried out and nothing abnormal could be observed. The bed was dug out and refilled with sand of D_{10} = 0.24 mm, and C_u = 3.9 the same sand as for bed No.1. This was to work as a control for bed No.1 to observe the effect of "red mud" in bed No.1 in degree of treatment, particularly regarding removal of phosphates.

The bed was started with a loading of $\frac{1}{2}$ gal. per sq. ft. (24 $1/m^2$) per day on July 29, 1970. This feed rate was increased to 1 gal. per sq. ft. (49 $1/m^2$) per day on September 17, 1970.

It was however, observed that the outflow of the treated effluent was relatively less than the inflow. The checking of the calibration of tipping bucket feed into beds No.1 and 4 indicated no error. Hence, the cause for this difference could have been attributed to some leakage of the effluent outside the building. There was no indication of any build-up of the waste in the bed nor were there any signs of ponding. Moreover, the dissolved oxygen of the effluent had been between 5.0 to 8.0 mg/l showing that the system was operating aerobically.

A portion of the bed was dug out on December 8, 1970. The sand appeared to be dry. On December 10, 1970, about 12 gallons (545 litres) of water was poured at one location on top of the bed; most of it, shortly afterwards, was received at the effluent outlet.

On December 11, 1970, another 12 gallons (545 litres) were poured at a different spot. No effluent appeared. There appears to be some break in the plastic lining of the box through which the effluent could be discharging from the bottom of the bed away from the building underground.

The values for the various indicators are shown in Table 6. The BOD values for 50% and 85% of the samples were 1.4 and 7.4 mg/l or less, respectively. The corresponding values for the suspended solids were less than 1.0 and 1.6 mg/l respectively. The volatile solids were always less than 1.0 mg/l.

In more than 50% of the samples, free ammonia (N) could not be detected. Considering 85% of the samples, the value was 2.3 mg/l or less.

The nitrite and nitrate (N), for 50% of the samples were 0.075 and 40.0 mg/l or less, respectively. The corresponding values for 85% of the samples were 1.8 and 66.0 mg/l.

The ABS content was 0.45 and 0.65 mg/l or less for 50% and 85% of the samples, respectively.

The total and fecal coliform counts for 50% of the samples were 1,450 and 290/100 ml or less, respectively, and for 85% of the samples, they were 60,000 and 18,000/100 ml or less, respectively.

Total phosphate (PO_4) for 85% of the time was 36.5 mg/l or less and for 50% of the samples was 28.0 mg/l or less.

FILTER BED NO.5 - D_{10} = 1.0 mm, C_u = 2.1

The top soil covering the filter was removed and the level of the distributor pipes was checked early in July, 1970. The bed was again covered with the top soil.

The values for the various indicators are shown in Table 7.

Filter bed No.5 has been operating satisfactorily without any major problems. The values of the various indicators in general showed

a slight improvement in the quality of the effluent. The free ammonia (N) and nitrite (N) values, for 85% of the samples were 5.6 and 0.73 mg/l respectively as compared to 13.0 and 1.6 mg/l mentioned in the previous report.

The values of BOD and Suspended Solids for 85% of the samples were equal to or less than 4.3 and 1.7 mg/l respectively as compared to 6.2 and 4.2 mg/l mentioned in the previous report.

Total and fecal coliform counts were 250,000/100ml and 100,000/100 ml, respectively as compared to 4,300,000/100 ml and 450,000/100 ml in the last report.

There was no significant change in total phosphate (PO_4), and ABS . The values were 53.0 and 0.84 mg/l, respectively. The corresponding values were 47.0 and 1.0 mg/l in the previous report.

FILTER BED NO.6 - D_{10} = 2.5 mm, C_u = 1.2

The top soil was removed and the level of the distributor pipes were checked for this as for bed No.5 in July, 1970. The bed No.6 continued operating satisfactorily. The results of analyses are shown in Table 8. The values of BOD and Suspended Solids for 50% of the time were less than 3.8 and 1.3 mg/l respectively. Considering however, 85% of the time, the respective values were 8.0 and 7.6 mg/l or less.

There appeared to be a considerable reduction in free ammonia (N) during this period. The values for 50% and 85% of the time were equal to or less than 4.9 and 8.9 mg/l respectively. In the previous report the corresponding values were 8.8 and 27.0 mg/l. The total

phosphate (PO_4) and ABS did not show any significant change, the values being 58.0 and 1.0 mg/l, respectively. The total and fecal coliform counts were very high as before, and in the range of 6,000,000 to 1,500,000/100 ml, respectively.

FILTER BEDS 1 and 4

Filter Beds No.1 and 4, both contain the same filter media with the only difference that Bed No.1 has 8 inches (20 cm) of filter sand mixed with 4% of "red mud". The intention was to determine the effect of "red mud" in Bed No.1 on the operation of the system and Bed No.4 would be the control. The results for comparison are shown in Summary Table 10.

It is observed that there had been a considerable difference in the phosphate and coliform counts. The values of total phosphate (PO_4) in 50% and 85% of the samples in Bed No.1 were 5.0 and 7.3 mg/l. This was apparently due to the combination of phosphates with iron, aluminum and calcium salts in the "red mud". The corresponding values for phosphate (PO_4) in the control Bed No.4 were 28.0 and 36.5 mg/l. The septic tank effluent had total phosphate (PO_4) of 41.5 and 66.0 mg/l or less in 50% and 85% of the samples.

The total and fecal coliform counts in 85% of the samples in Bed No.1 were 8,000 and 4,200/100 ml., respectively whereas the corresponding values in Bed No.4 were 60,000 and 18,000/100 ml. respectively.

There was no significant difference in the values of other indicators for comparing performances of the two beds.

DISCUSSION

The laboratory analyses of the effluent from the septic tank and the filter beds for August 5, 1970, is given in Table 1 as an example

For comparing the changes in performance, the results of the Interim Report Part I are shown together with the results of the present report in the Effluent Quality Tables 11 to 25.

It might be appreciated that filter beds No.1 and 4 were filled in July, 1970, with filter media having D_{10} of 0.24 mm and C_u of 3.9. Since results for these beds with the new filter media could not be compared with those for the media used earlier, the figures for that period, for those two filter beds are not shown.

All the beds have been showing satisfactory performance.

Apparently there has been some leak in bed No.4. Consequently discharge of the treated effluent received in the building was interrupted as part of it could have been discharging from the bottom of the bed outside into the field. If, however, the waste was collected in the tank and then periodically discharged into the bed, about 50% of it could be received in the building.

BOD and COD - Tables 11 & 12

The BOD values for 50% of the time for the six beds were in the range of 2.8 to 5.2 mg/l and for 85% they were 4.3 to 9.5 mg/l or less. There was no significant difference from those reported earlier. For 85% of the samples, these were 6.2 to 10.0 mg/l or less.

The COD values for 85% of the samples were between 36.0 and 64.0 mg/l The corresponding values in the first report were 48.0 to 78.0 mg/l.

This might be considered as slight improvement. The septic tank effluent had BOD and COD values for 85% of the samples equal to 310.0 and 435 mg/l or less respectively. The percentage reduction for BOD was 97 to 98%.

SUSPENDED SOLIDS AND VOLATILE SUSPENDED SOLIDS - Table 13 & 14

For the Suspended Solids in 50% and 85% of the samples, during the period of this report were in the range of< 1.0 to 2.3 mg/l and 1.5 to 7.6 mg/l respectively. The corresponding ranges in the previous report were 1.0 to 4.3 mg/l and 3.5 to 10.5 mg/l respectively. The septic tank effluent had Suspended Solids of 153 mg/l or less in 85% of the samples. The Suspended Solids reduction by the treatment process was 95 to 99%. The Volatile Suspended Solids in 85% of the samples in beds No. 1 to 5 were less than 1.5 mg/l. In bed No. 6, however, these were equal to or less than 4.3 mg/l.

FREE AMMONIA (N) - Table 15

Considering nitrogen compounds, there appeared to be a considerable improvement in the stabilization process of the waste. The free ammonia content in the filter bed effluents reported earlier for 50% and 85% of the samples were in the ranges of 0.1 to 8.8 mg/l and 8.0 to 27.0 mg/l respectively, were reduced to 0.06 to 4.9 and 1.7 to 9.4 mg/l respectively.

The septic tank effluent had a value of free ammonia (N) of 37.0 mg/l.

ORGANIC NITROGEN (N) - Table 16

For the organic nitrogen for 50% of the samples was less than 0.48 mg/l and for 85% of the samples, less than 0.80 mg/l. During the period of Part I report, the corresponding values were 0.76 mg/l and 1.9 mg/l.

NITRITE (N) - Table 17

The nitrite content in 50% of the samples was between 0.08 and 0.52 mg/l and in 85% of the samples 0.66 to 1.80 mg/l. The respective figures in the previous report were 0.30 to 0.64 and 0.60 to 1.90 mg/l. There was no appreciable change, and this could have been due to conversion of free ammonia to nitrate, the nitrite being an intermediate step for the continuous oxidation process.

NITRATE (N) - Table 18

There was an increase in nitrate in the effluent from all the beds as was expected due to oxidation of free ammonia in aerobic environments. The concentration of nitrate in 50% of the samples was between 21.0 and 40.0 mg/l. For 85% of the samples it was between 39.0 and 66.0 mg/l. The resepctive values in the previous report were 16.0 to 27.0 mg/l and 24.0 to 40.0 mg/l. The values for septic tank effluent were always less than 1.0 mg/l nitrate (N).

PHOSPHATES (PO_4) - Table 19-21

The treatment of the waste for phosphate removal by "red mud" was very apparent from the results of bed No. 1. The total phosphate (PO_4) in 50% and 85% of the samples were 5.0 and 7.3 mg/l or less. In the control bed No. 4, without "red mud", the corresponding values were 28.0 and 36.5 mg/l or less.

The septic tank effluent had values of phosphates (PO_4) $\leq$ 41.5 and 66.0 mg/l in 50% and 85% of the samples respectively.

There was no significant reduction of phosphate in the effluent from other beds. The value for 85% being in the range of 44.0 to 58.0 58.0 mg/l.

There was relatively less phosphate (PO_4) in the effluent from bed No. 4 which could have been due to the smaller grainsize of the filter media containing perhaps some aluminum and calcium compounds.

ABS - Table 22

As before there was considerable reduction in ABS. The septic tank effluent contained $\leq$ 7.6 and 11.8 mg/l for 50% and 85% of the samples, respectively. The effluent from the six beds had ABS in the range of 0.45 to 0.66 mg/l in the 50% of the cases, and 0.65 to 1.25 in 85% of samples. Apparently there was no co-relation between ABS reduction and the grain size of filter media. Moreover, there was little change in these values as compared to those shown in the previous report.

TOTAL SOLIDS - Table 23

The values of total solids for 50% of the samples for all the beds, were in the range of 620 to 740 mg/l. The corresponding range in the previous report was 660 to 730 mg/l. In 85% of the samples, the values were between 715 and 900 mg/l as compared to 800 to 880 mg/l in the previous report. The corresponding total solids in the septic tank effluent were 660 mg/l.

Considering Suspended Solids for 85% of the samples of the final effluent from the six beds to be between 1.5 and 7.6 mg/l and in septic tank effluent to be 153 mg/l or less, there was a considerable increase in dissolved solids in the treated effluent, possibly due to oxidation processes during the treatment of the waste.

COLIFORMS - Table 24 & 25

There was a considerable reduction in the total and fecal coliform in the effluent from the beds as compared to that from septic tanks. The counts however, were still very high. In 85% of the samples, the total coliform counts were between 8,000 and 6,000,000/100 ml and the fecal coliforms were 4,200 to 1,500,000/100 ml. The bed No.6, as before showed relatively higher counts of the bacteria.

OBSERVATIONS AND CONCLUSIONS

The operation of four of the beds over an 18 month period and two for 9 months, has indicated that filter sands with effective sizes in the range of 0.24 to 2.5 mm and uniformity coefficients of 4.0 or less, have been providing satisfactory treatment to the waste.

The effluent from these beds had BOD of 6.1 and 9.5 mg/l or less for 50% and 85% of the time respectively. The corresponding values for Suspended Sclids were 2.3 and 7.6 mg/l.

There has been a gradual improvement in the nitrification processes.

The use of "red mud" containing mainly oxides of calcium, aluminum and iron mixed with filter sand of effective size 0.24 mm indicated a considerable reduction of phosphates. The concentration of phosphates (PO_4) in 85% of the samples of the effluent from this filter bed, was 7.3 mg/l or less as compared to the range of 36.5 to 58.0 mg/l in the other beds.

The effluents from all the systems contained fecal coliforms but their number appeared to be considerably reduced as compared to those in the septic tank effluent.

The Virus Laboratory has not detected any of the suspected viruses in any of the samples collected every two weeks since September, 1970.

The water usage during the period in the houses was in the range of 24.5 gal. (110 litre) to 41.0 gal. (187 litre) per capita per day. The average usage in the community was 38.8 gal. (177 litre) per capita per day.

Table 1 *

Laboratory Analyses of Effluent

Samples Collected on August 5, 1970. *

Effluent	NITROGEN mg/l				PHOSPHATE (PO_4) mg/l		COD mg/l	ABS mg/l	TSS mg/l	Volatile Solids mg/l	Total Solids mg/l	PH in lab	BOD mg/l	Coliforms x 10^3/ 100 ml	
	Free NH_3	Org. N	Nitrite	Nitrate	Total	Soluble								Total	Faecal
Septic Tank Effluent	43.20	3.00	0.001	0.3	53.0	40.5	240	6.85	104.0	11.0	555	6.9	165.0	18,000	6,400
Filter Bed #1	5.90	0.66	2.750	12.5	4.8	3.0	25	0.35	2.8	< 1.0	570	7.7	6.0	28.00	3.10
Filter Bed #2	14.10	0.96	1.150	17.5	38.0	25.5	50	0.72	6.0	"	580	7.0	5.9	55.00	46.00
Filter Bed #3	0.06	0.54	0.175	46.5	47.0	30.5	25	0.50	1.20	"	712	7.2	1.5	56.00	20.00
Filter Bed #4	0.81	0.48	0.625	25.6	14.0	9.0	10	0.30	< 1.0	"	586	7.4	3.7	0.65	0.49
Filter Bed #5	0	0.66	0.075	46.5	40.0	30.5	20	0.48	"	"	797	7.0	1.3	0.58	0.37
Filter Bed #6	3.21	0.54	1.150	38.0	51.0	35.5	25	0.55	4.4	"	640	7.1	5.6	4.70	0.39

* Similar laboratory analyses are on file for remainder of period - July 1970 to March 1971

TABLE 2

WATER USAGE 1970-71
GALLONS PER CAPITA PER DAY

House/ Month	1	2	3	4	5	6	7	Community
1970								
August	45.1	46.2	31.8	-	46.4	20.9	-	38.1
September	33.4	29.9	36.9	41.9	35.9	34.3	47.5	42.8
October	44.9	36.7	32.8	38.3	38.8	43.2	32.1	40.1
November	47.6	23.9	32.5	37.6	35.4	49.2	32.4	37.5
December	41.7	25.4	35.6	40.6	33.4	45.5	32.8	35.5
1971								
January	22.7	6.1	33.7	41.1	34.4	44.2	36.7	34.1
February	46.6	23.5	32.5	40.9	33.9	37.0	31.4	45.2
March	51.4	23.2	30.6	42.7	39.8	46.0	33.1	39.4
April	27.9	5.8	37.8	39.7	39.5	48.7	33.6	36.2
Average	40.1	24.5	33.8	40.3	37.5	41.0	34.9	38.8

TABLE 3

STATISTICAL ANALYSES
OF
SAMPLE RESULTS

BED 1

	% of time equal to or less than		
	15	50	85
		* Values	
BOD	0.5	1.7	5.5
COD	19	27	39
Suspended Solids	< 1.0	< 1.0	1.5
Volatile Solids	< 1.0	< 1.0	< 1.0
Total Solids	640	700	780
Free Ammonia (N)	0	0.06	1.70
Organic (N)	0.23	0.38	0.62
Nitrite (N)	0.02	0.17	1.0
Nitrate (N)	20.0	32.0	52.0
ABS	0.28	0.47	0.79
Total Phosphates (PO_4)	3.6	5.0	7.3
Ortho Phosphates (PO_4)	2.8	4.6	7.1
Poly Phosphates (PO_4)	0	0.22	1.1
Total Coliform/100 ml x 1000	0.06	0.71	8.0
Fecal Coliform/100 ml x 1000	0.03	0.29	4.2
Iron Unfiltered	Traces	Traces	Traces
Iron Filtered	Traces	Traces	Traces

* All values are in mg/l (ppm) except for Coliforms

TABLE 4

STATISTICAL ANALYSES
OF
SAMPLE RESULTS

BED 2

	% of time equal to or less than 15	50 * Values	85
BOD	3.8	6.1	9.5
COD	20	32	50
Suspended Solids	< 1.0	< 1.0	3.5
Volatile Solids	< 1.0	< 1.0	< 1.0
Total Solids	600	740	900
Free Ammonia (N)	2.1	4.5	9.0
Organic (N)	0.29	0.48	0.70
Nitrite (N)	0.35	0.52	0.66
Nitrate (N)	17.0	26.0	39.0
ABS	0.33	0.64	1.25
Total Phosphates (PO_4)	25.0	33.0	44.0
Ortho Phosphates (PO_4)	14.5	20.0	29.0
Poly Phosphates (PO_4)	10.0	12.0	14.5
Total Coliform/100 ml x 1000	0.4	10.0	110.0
Fecal Coliform/100 ml x 1000	0.2	3.5	60.0

* All values are in mg/l (ppm) except for Coliforms

TABLE 5

STATISTICAL ANALYSES
OF
SAMPLE RESULTS

BED 3

	% of time equal to or less than 15 * Values	50	85
BOD	0.9	2.6	8.1
COD	23	37	59
Suspended Solids	<1.0	1.0	2.4
Volatile Solids	<1.0	<1.0	1.5
Total Solids	580	660	760
Free Ammonia (N)	0	1.0	8.0
Organic (N)	0.28	0.42	0.64
Nitrite (N)	0.084	0.260	0.840
Nitrate (N)	20.0	32.0	52.0
ABS	0.36	0.66	1.2
Total Phosphates (PO_4)	25.0	37.0	54.0
Ortho Phosphates (PO_4)	16.0	25.0	40.0
Poly Phosphates (PO_4)	7.2	10.0	14.5
Total Coliform/100 ml x 1000	0.95	30.0	900.0
Fecal Coliform/100 ml x 1000	0.27	6.2	150.0

* All values are in mg/l (ppm) except Coliforms

TABLE 6

STATISTICAL ANALYSES
OF
SAMPLE RESULTS

BED 4

	% of time equal to or less than		
	15	50	85
	* Values		
BOD	0.3	1.4	7.4
COD	14	22	36
Suspended Solids	<1.0	<1.0	1.6
Volatile Solids	<1.0	<1.0	<1.0
Total Solids	650	730	820
Free Ammonia (N)	0	0	2.3
Organic (N)	0.17	0.31	0.57
Nitrite (N)	0.003	0.075	1.8
Nitrate (N)	29.0	40.0	66.0
ABS	0.30	0.45	0.65
Total Phosphates (PO_4)	21.5	28.0	36.5
Ortho Phosphates (PO_4)	13.0	18.0	26.0
Poly Phosphates (PO_4)	7.6	10.0	13.0
Total Coliform/100 ml x 1000	0.04	1.45	60.0
Fecal Coliform/100 ml x 1000	0.004	0.29	18.0

* All values are in mg/l (ppm) except for Coliform

TABLE 7

STATISTICAL ANALYSES
OF
SAMPLE RESULTS

BED 5

	% of time equal to or less than 15	50	85
	* Values		
BOD	0.6	1.6	4.3
COD	16	26	43
Suspended Solids	<1.0	<1.0	1.7
Volatile Solids	<1.0	<1.0	<1.0
Total Solids	620	720	840
Free Ammonia (N)	0	0.11	5.6
Organic (N)	0.26	0.41	0.63
Nitrite (N)	0.028	0.140	0.730
Nitrate (N)	19.0	31.0	50.0
ABS	0.30	0.50	0.84
Total Phosphates (PO_4)	25.5	36.0	53.0
Ortho Phosphates (PO_4)	15.5	26.0	43.0
Poly Phosphates (PO_4)	8.5	11.0	14.5
Total Coliform/100 ml x 1000	0.19	6.6	250.0
Fecal Coliform/100 ml x 1000	0.09	3.0	100.0

* All values are in mg/l (ppm) except for Coliforms

TABLE 8

STATISTICAL ANALYSES
OF
SAMPLE RESULTS

BED 6

	% of time equal to or less than		
	15	50	85
		* Values	
BOD	1.8	3.8	8.0
COD	23	39	64
Suspended Solids	< 1.0	2.3	7.6
Volatile Solids	< 1.0	1.0	4.3
Total Solids	545	620	715
Free Ammonia (N)	2.7	4.9	8.9
Organic (N)	0.29	0.48	0.80
Nitrite (N)	0.18	0.39	0.85
Nitrate (N)	9.6	21.0	45.0
ABS	0.36	0.61	1.0
Total Phosphates (PO_4)	23.0	36.5	58.0
Ortho Phosphates (PO_4)	15.0	36.0	45.0
Poly Phosphates (PO_4)	5.8	9.4	15.0
Total Coliform/100 ml x 1000	0.88	67.0	6,000
Fecal Coliform/100 ml x 1000	0.70	31.0	1,500

* All values are in mg/l (ppm) except for Coliform

TABLE 9

STATISTICAL ANALYSES
OF
SAMPLE RESULTS

SEPTIC TANKS EFFLUENT

	% of time equal to or less than		
	15	50	85
	* Values		
BOD	58.0	135.0	310.0
COD	140	245	435
Suspended Solids	28.0	65.0	153.0
Volatile Solids	9.5	28.5	92.0
Total Solids	520	580	660
Free Ammonia (N)	14.3	23.0	37.0
Organic (N)	0.80	1.7	3.5
Nitrite (N)	< 0.001	< 0.001	0.092
Nitrate (N)	< 0.1	0.1	0.9
ABS	5.0	7.6	11.8
Total Phosphates (PO_4)	26.5	41.5	66.0
Ortho Phosphates (PO_4)	17.4	30.5	54.0
Poly Phosphates (PO_4)	6.7	9.4	13.1
Total Coliform/100 ml x 1000	2,100.0	9,100.0	42,000.0
Fecal Coliform/100 ml x 1000	730.0	2,200.0	6,600.0
Iron Unfiltered (Fe)	0.15	0.37	0.96
Iron Filtered (Fe)	Trace	Trace	0.12

* All values are in mg/l (ppm) except for Coliforms

TABLE 10
FILTER BEDS #1 and #4

Effect of Red Mud in Bed #1 on Effluent quality

	Percentage of Samples					
	15%		50%		85%	
	** Values equal to or less than					
	Bed 1	Bed 4	Bed 1	Bed 4	Bed 1	Bed 4
BOD	0.5	0.3	1.7	1.4	5.5	7.4
COD	19	14	27	22	39	36
Suspended Solids	1.0	1.0	1.0	1.0	1.5	1.6
Volatile Solids	1.0	1.0	1.0	1.0	1.0	1.0
Total Solids	640	650	700	730	780	820
Free Ammonia (N)	0	0	0.06	0	1.70	2.30
Organic (N)	0.23	0.17	0.38	0.31	0.62	0.57
Nitrite (N)	0.020	0.003	0.170	0.075	1.000	1.800
Nitrate (N)	20.0	29.0	32.0	40.0	52.0	66.0
ABS	0.28	0.30	0.47	0.45	0.79	0.65
Total Phosphates (PO_4)	3.6	21.5	5.0	28.0	7.3	36.5
Poly Phosphates (PO_4)	0	7.6	0.2	10.0	1.1	13.0
Ortho Phosphates (PO_4)	2.8	13.0	4.6	18.0	7.1	26.0
Total Coliform x 10^3/100 ml	0.06	0.04	0.71	1.45	8.00	60.00
Fecal Coliform x 10^3/100 ml	0.03	0.004	0.29	0.29	4.20	18.00
Iron Unfiltered (Fe)	Traces	-	Traces	-	Traces	-
Iron Filtered (Fe)	Traces	-	Traces	-	Traces	-

** All values except Coliform in mg/l

TABLE 11

SUMMARY OF STATISTICAL ANALYSES

EFFLUENT QUALITY BOD mg/l

Filter Bed	V A L U E S 15 -50 -85% of time equal or less than					
	15		50		85	
	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1969-1970
Septic Tank Effluent	58.0	43.0	135.0	86.0	310.0	170.0
Filter Bed # 1	0.5	-	1.7	-	5.5	-
Filter Bed # 2	3.8	1.2	6.1	2.9	9.5	7.0
Filter Bed # 3	0.9	1.2	2.6	3.2	8.1	8.6
Filter Bed # 4	0.3	2.1	1.4	-	7.4	-
Filter Bed # 5	0.6	1.2	1.6	2.8	4.3	6.2
Filter Bed # 6	1.7	2.7	3.8	5.2	8.0	10.0

TABLE 12

SUMMARY OF STATISTICAL ANALYSIS COD mg/l

EFFLUENT QUALITY

	V A L U E S 15 -50 -85% of time equal or less than					
	15		50		85	
	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1969-1970
Septic Tank Effluent	140	82	245	180	435	400
Filter Bed # 1	19	-	27	-	39	-
Filter Bed # 2	20	21	32	33	50	53
Filter Bed # 3	23	21	37	34	59	56
Filter Bed # 4	14	-	22	-	36	-
Filter Bed # 5	16	22	26	33	43	48
Filter Bed # 6	23	26	39	45	64	78

TABLE 13

SUMMARY OF STATISTICAL ANALYSIS

EFFLUENT QUALITY

Suspended Solids
mg/l

Filter Bed	V A L U E S 15 -50 -85% of time equal to or less than					
	15		50		85	
	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1969-1970
Septic Tank Effluent	28.0	45.0	65.0	72.0	153.0	120.0
Filter Bed # 1	<1.0	-	<1.0	-	1.5	-
Filter Bed # 2	<1.0	<1.0	<1.0	1.8	3.5	5.0
Filter Bed # 3	<1.0	<1.0	<1.0	<1.0	2.4	3.5
Filter Bed # 4	<1.0	-	<1.0	-	1.6	-
Filter Bed # 5	1.0	<1.0	1.0	1.6	1.7	4.2
Filter Bed # 6	1.0	1.8	2.3	4.3	7.6	10.5

TABLE 14

SUMMARY OF STATISTICAL ANALYSIS

EFFLUENT QUALITY

Volatile Suspended Solids
mg/l

Filter Bed	V A L U E S 15 -50 -85% of time equal to or less than					
	15		50		85	
	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1969-1970
Septic Tank Effluent	9.5	-	28.5	-	92.0	-
Filter Bed # 1	<1.0	-	<1.0	-	<1.0	-
Filter Bed # 2	<1.0	-	<1.0	-	<1.0	-
Filter Bed # 3	<1.0	-	<1.0	-	1.5	-
Filter Bed # 4	<1.0	-	<1.0	-	<1.0	-
Filter Bed # 5	1.0	-	1.0	-	1.0	-
Filter Bed # 6	<1.0	-	1.1	-	4.3	-

TABLE 15

SUMMARY OF STATISTICAL ANALYSIS

EFFLUENT QUALITY

Free Ammonia
N
mg/l

Filter Bed	V A L U E S 15 -50 -85% of time equal to or less than					
	15		50		85	
	1970-1971	1969-1970	1970-1971	1969-1970	1970-1971	1969-1970
Septic Tank Effluent	14.30	17.00	23.00	26.00	37.00	40.00
Filter Bed # 1	0	-	0.06	-	1.70	-
Filter Bed # 2	2.10	4.00	3.30	7.80	9.40	15.00
Filter Bed # 3	0	0.10	1.03	0.10	8.00	8.00
Filter Bed # 4	0	-	0	-	2.30	-
Filter Bed # 5	0	0.30	0.11	4.00	5.60	13.00
Filter Bed # 6	2.70	2.90	4.90	8.80	8.80	27.00

TABLE 16

SUMMARY OF STATISTICAL ANALYSIS

EFFLUENT QUALITY

Organic N.
mg/l

Filter Bed	V A L U E S 15 -50 -85% of time equal to or less than					
	15		50		85	
	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1970-1970	Part II 1970-1971	Part I 1969-1970
Septic Tank Effluent	0.80	1.30	1.70	1.80	3.50	2.50
Filter Bed # 1	0.23	-	0.38	-	0.62	-
Filter Bed # 2	0.29	0.30	0.48	0.52	0.80	0.88
Filter Bed # 3	0.28	0.17	0.42	0.35	0.64	0.76
Filter Bed # 4	0.17	-	0.31	-	0.57	-
Filter Bed # 5	0.26	0.17	0.41	0.42	0.63	1.05
Filter Bed # 6	0.29	0.31	0.48	0.76	0.80	1.90

TABLE 17

SUMMARY OF STATISTICAL ANALYSIS

EFFLUENT QUALITY

Nitrite
mg/l

Filter Bed	V A L U E S 15 -50 -85% of time equal to or less than					
	15		50		85	
	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1969-1970
Septic Tank Effluent	0.001	0.001	0.001	0.001	0.092	0.015
Filter Bed # 1	0.020	-	0.170	-	1.000	-
Filter Bed # 2	0.330	0.160	0.520	0.300	0.660	0.600
Filter Bed # 3	0.084	0.190	0.260	0.600	0.840	1.900
Filter Bed # 4	0.003	-	0.080	-	1.800	-
Filter Bed # 5	0.028	0.100	0.140	0.400	0.730	-
Filter Bed # 6	0.180	0.260	0.390	0.640	0.850	1.600

TABLE 18

SUMMARY OF STATISTICAL ANALYSIS

EFFLUENT QUALITY

Nitrate N
mg/l

Filter Bed	V A L U E S 15 -50 -85% of time to or less than					
	15		50		85	
	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1969-1970
Septic Tank Effluent	0.1	0.1	0.1	0.1	0.9	1.0
Filter Bed # 1	20.0	-	32.0	-	52.0	-
Filter Bed # 2	17.0	12.0	26.0	19.0	39.0	28.0
Filter Bed # 3	20.0	19.0	32.0	27.0	52.0	40.0
Filter Bed # 4	29.0	-	40.0	-	66.0	-
Filter Bed # 5	19.0	16.0	31.0	25.0	50.0	37.0
Filter Bed # 6	9.6	11.0	21.0	16.0	45.0	24.0

TABLE 19

SUMMARY OF STATISTICAL ANALYSIS

EFFLUENT QUALITY

Total Phosphates (PO_4) mg/l

Filter Bed	V A L U E S 15 -50 -85% of time equal to or less than					
	15		50		85	
	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1969-1970
Septic Tank Effluent	26.5	20.0	41.5	37.0	66.0	68.0
Filter Bed # 1	3.6	-	5.0	-	7.3	-
Filter Bed # 2	25.0	18.0	33.0	30.0	44.0	50.0
Filter Bed # 3	25.0	25.0	37.0	35.0	54.0	56.0
Filter Bed # 4	21.5	-	28.0	-	36.5	-
Filter Bed # 5	25.5	20.0	36.0	30.0	53.0	47.0
Filter Bed # 6	23.0	23.0	36.5	33.0	58.0	48.0

TABLE 20

SUMMARY OF STATISTICAL ANALYSIS

EFFLUENT QUALITY

Ortho Phosphates (PO_4) mg/l

Filter Bed	V A L U E S 15 -50 -85% of time equal to or less than					
	15		50		85	
	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1969-1970
Septic Tank Effluent	17.4	10.0	30.5	20.0	54.0	38.0
Filter Bed # 1	2.8	-	4.6	-	7.1	-
Filter Bed # 2	14.5	12.0	20.0	16.0	29.0	22.0
Filter Bed # 3	16.0	13.0	25.0	21.0	40.0	35.0
Filter Bed # 4	13.0	-	18.0	-	26.0	-
Filter Bed # 5	15.5	12.0	26.0	19.0	43.0	30.0
Filter Bed # 6	15.0	13.0	36.0	21.0	45.0	36.0

TABLE 21

SUMMARY OF STATISTICAL ANALYSIS

EFFLUENT QUALITY

Poly Phosphates (PO_4) mg/l

Filter Bed	V A L U E S 15 -50 -85% of time equal to or less than					
	15		50		85	
	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1979-1970	Part II 1970-1971	Part I 1979-1970
Septic Tank Effluent	6.7	6.0	9.4	9.8	13.1	16.0
Filter Bed # 1	-	-	0.2	-	1.1	-
Filter Bed # 2	10.0	5.0	12.0	7.4	14.5	11.0
Filter Bed # 3	7.2	74.0	10.0	11.0	14.5	15.0
Filter Bed # 4	7.6	-	11.0	-	13.0	-
Filter Bed # 5	8.5	86.0	11.0	13.0	14.5	20.0
Filter Bed # 6	5.8	8.0	9.4	11.0	15.0	15.0

TABLE 22

SUMMARY OF STATISTICAL ANALYSIS

EFFLUENT QUALITY

ABS
mg/l

	V A L U E S 15 -50 -85% of time equal to or less than					
	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1969-1970
Septic Tank Effluent	5.00	2.20	7.60	3.30	11.80	5.00
Filter Bed # 1	0.28	-	0.47	-	0.79	-
Filter Bed # 2	0.33	0.20	0.64	0.54	1.25	1.50
Filter Bed # 3	0.36	0.27	0.66	0.48	1.20	0.86
Filter Bed # 4	0.30	-	0.45	-	0.65	-
Filter Bed # 5	0.30	0.24	0.50	0.50	0.84	1.00
Filter Bed # 6	0.36	0.31	0.61	0.55	1.00	0.96

TABLE 23

SUMMARY OF STATISTICAL ANALYSIS

EFFLUENT QUALITY

Total Solids
mg/l

Filter Bed	V A L U E S 15 -50 -85% of time equal to or less than					
	15		50		85	
	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1969-1970
Septic Tank Effluent	520	550	580	660	660	790
Filter Bed # 1	640	-	700	-	780	-
Filter Bed # 2	600	630	740	730	900	880
Filter Bed # 3	580	600	660	720	760	880
Filter Bed # 4	650	-	730	-	820	-
Filter Bed # 5	620	620	720	715	840	880
Filter Bed # 6	545	540	620	660	715	800

TABLE 24

SUMMARY OF STATISTICAL ANALYSIS

EFFLUENT QUALITY

Total Coliforms x 10^3 per 100 ml

Filter Bed	V A L U E S 15 -50 -85% of time equal to or less than					
	15		50		85	
	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1969-1970
Septic Tank Effluent	2,100.00	4,400.00	9,100.00	8,000.00+	42,000.00	8,000.00+
Filter Bed # 1	0.06	-	0.71	-	8.00	-
Filter Bed # 2	0.40	0.66	10.00	90.00	110.00	600.00
Filter Bed # 3	0.95	0.52	30.00	35.00	900.00	2,000.00
Filter Bed # 4	0.04	-	1.45	-	60.00	-
Filter Bed # 5	0.19	0.34	6.60	40.00	250.00	4,300.00
Filter Bed # 6	0.88	10.00	67.00	540.00	660,000.00	8,000.00+

TABLE 25

SUMMARY OF STATISTICAL ANALYSIS

EFFLUENT QUALITY

Faecal Coliforms x10^3 per 100 ml

Filter Bed	V A L U E S 15 -50 -85% of time equal to or less than					
	15		50		85	
	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1969-1970	Part II 1970-1971	Part I 1969-1970
Septic Tank Effluent	730.00	250.00	2,200.00	800.00 +	6,600.00	800.00 +
Filter Bed # 1	0.03	-	0.29	-	4.20	-
Filter Bed # 2	0.20	0.06	3.50	10.00	6.00	160.00
Filter Bed # 3	0.27	0.18	6.20	4.40	40.00	100.00
Filter Bed # 4	0.004	-	0.29	-	18.00	-
Filter Bed # 5	0.09	0.13	3.00	7.00	100.00	450.00
Filter Bed # 6	0.70	2.20	31.00	38.00	1,500.00	640.00

APPENDIX I

ANALYSIS OF RED MUD SAMPLES
(June 11, 1970)

APPENDIX I

Analyses of Red Mud Samples (June 11, 1970)

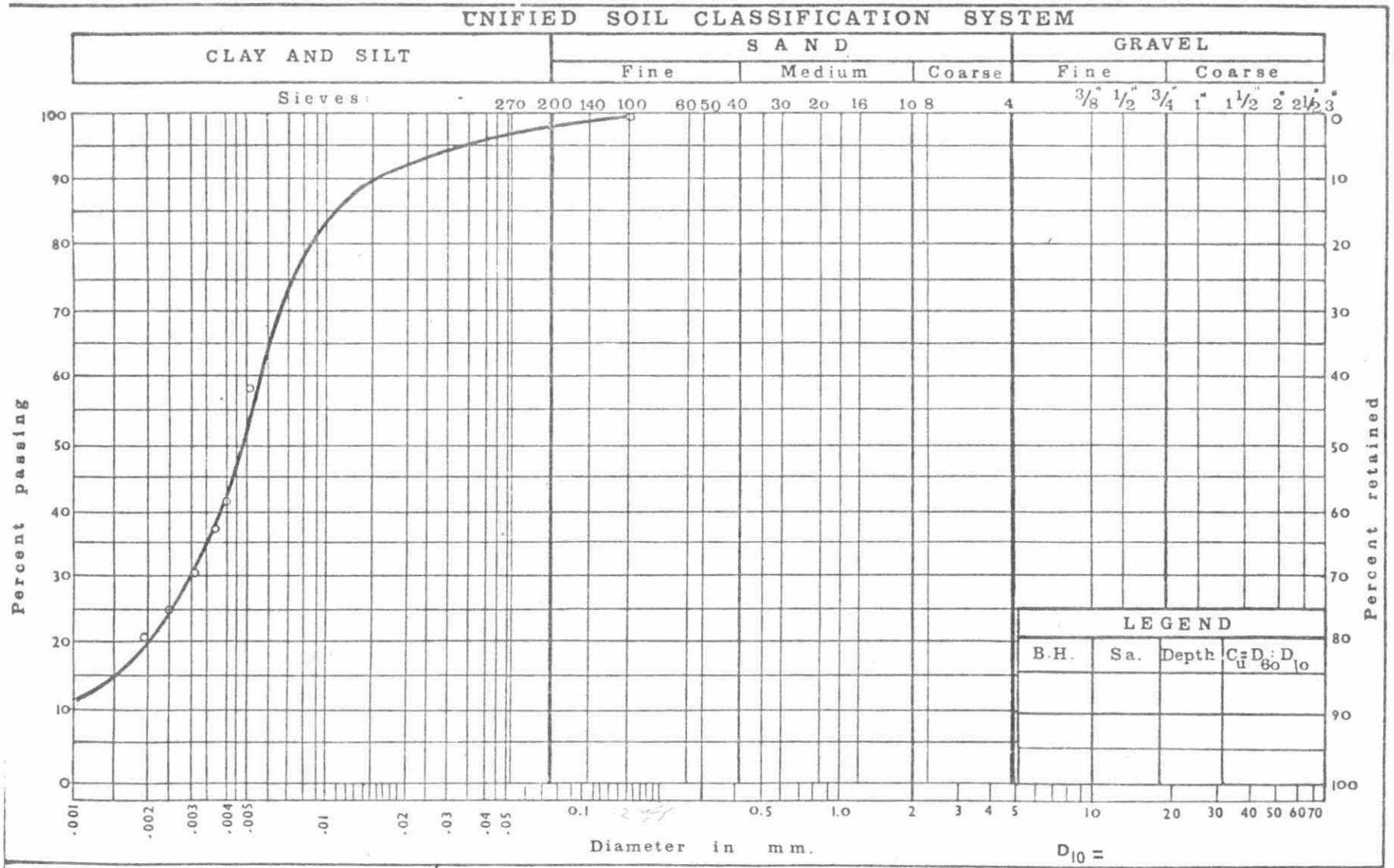
WHOLE MUD

grams per liter solids	332
titrable soda as Na_2CO_3%	11.6

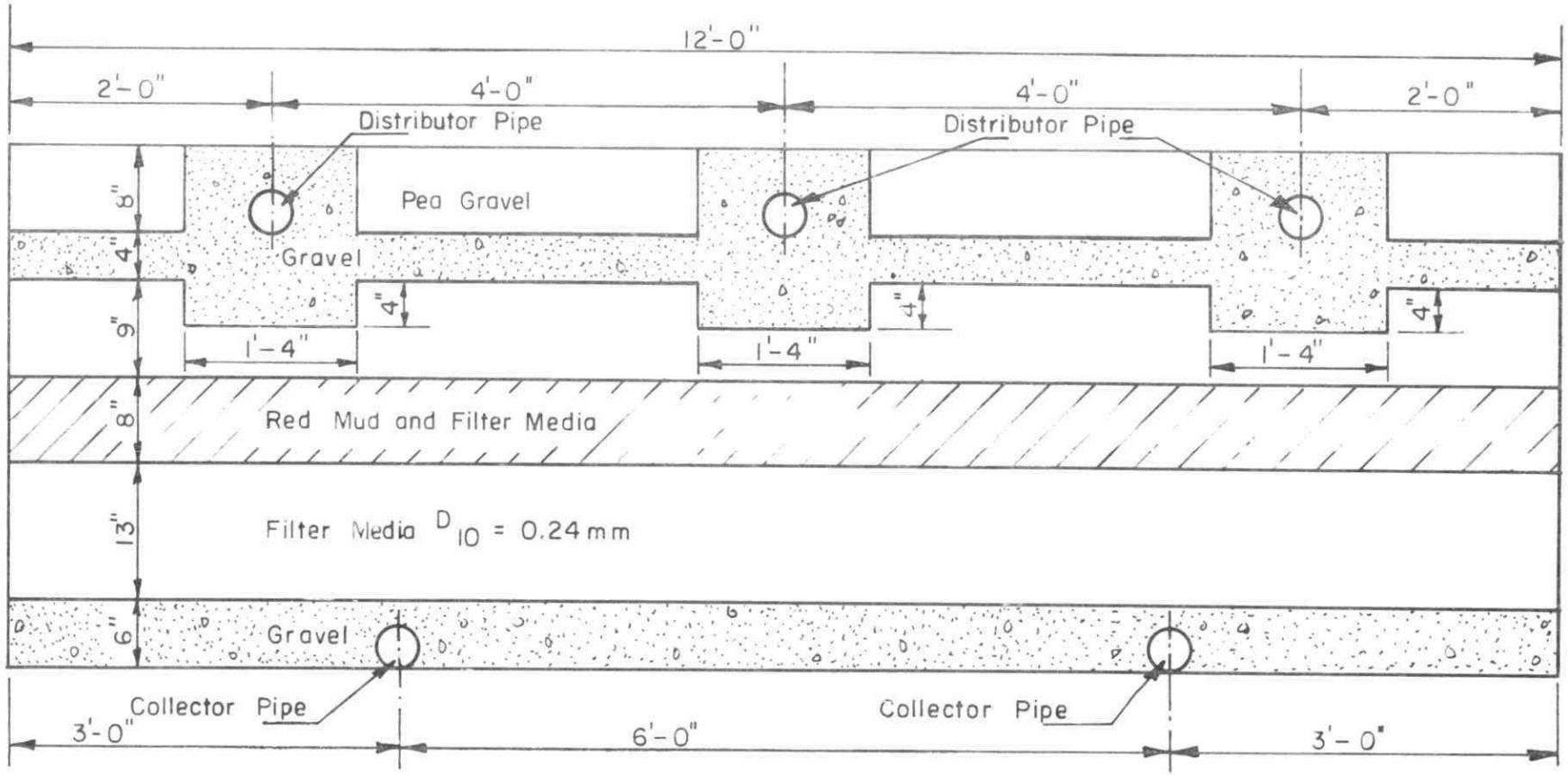
DRY BASIS (percent)

SiO_2	16.7
CaO	2.5
Na_2O	8.8
Al_2O_3	22.7
Fe_2O_3	25.7

APPENDIX I


UNIFIED SOIL CLASSIFICATION SYSTEM
CLAY AND SILT
SAND
Fine
Medium
Coarse
GRAVEL
Fine
Coarse
Sieves:
270 200 140 100 60 50 40 30 20 16 10 8 4
3/8" 1/2" 3/4" 1" 1 1/2" 2" 2 1/2" 3"
Percent passing
Percent retained
100 90 80 70 60 50 40 30 20 10 0
.001 .002 .003 .004 .005 .01 .02 .03 .04 .05 0.1 0.5 1.0 2 3 4 5 10 20 30 40 50 60 70
Diameter in mm.
LEGEND
B.H.
Sa.
Depth
$C_u = D_{60} : D_{10}$
D_{10} =
Ontario
Ministry of the Environment.
Private Waste & Water Management
GRAIN SIZE DISTRIBUTION
"RED MUD"
Job No:
Site:

APPENDIX I

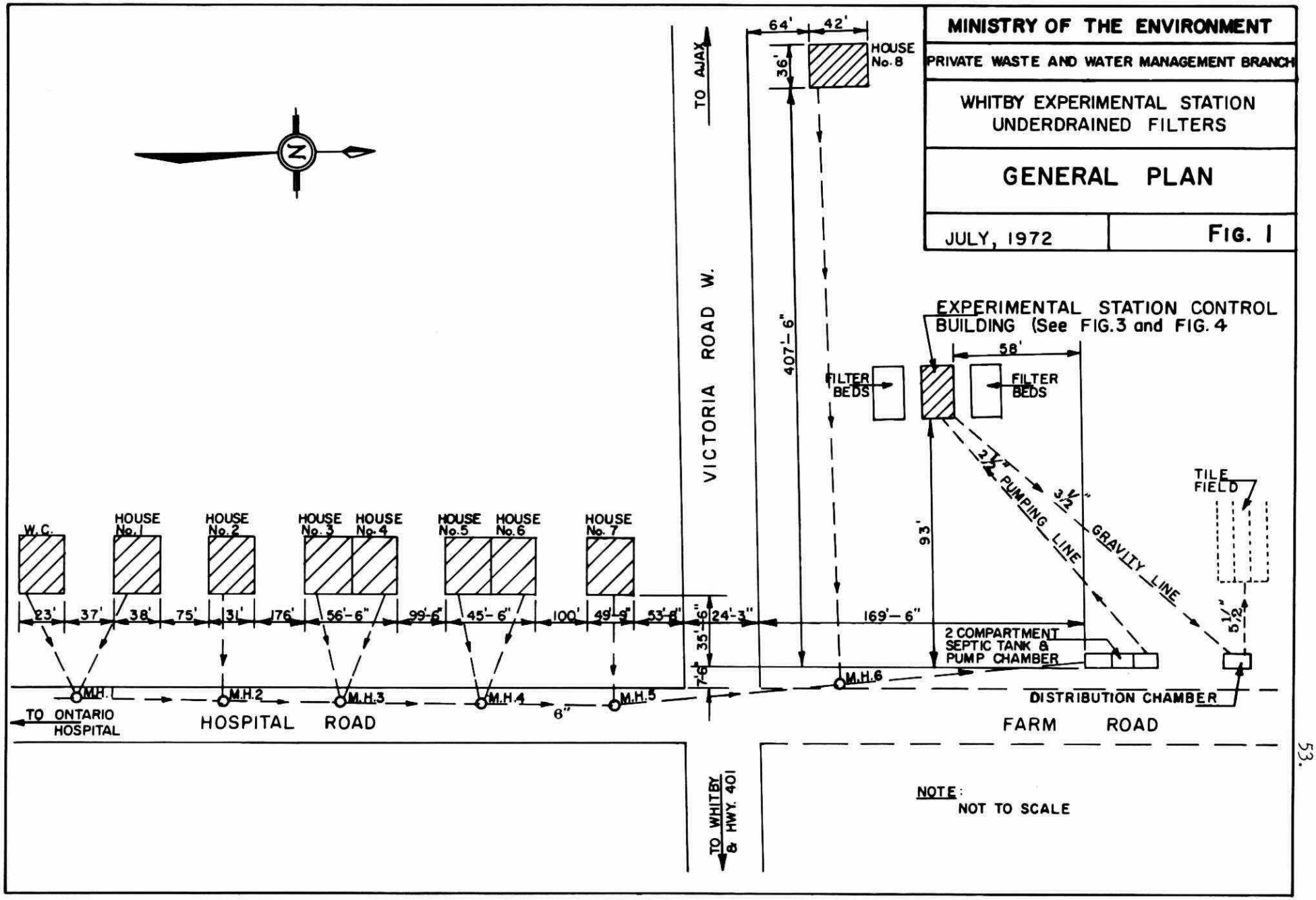


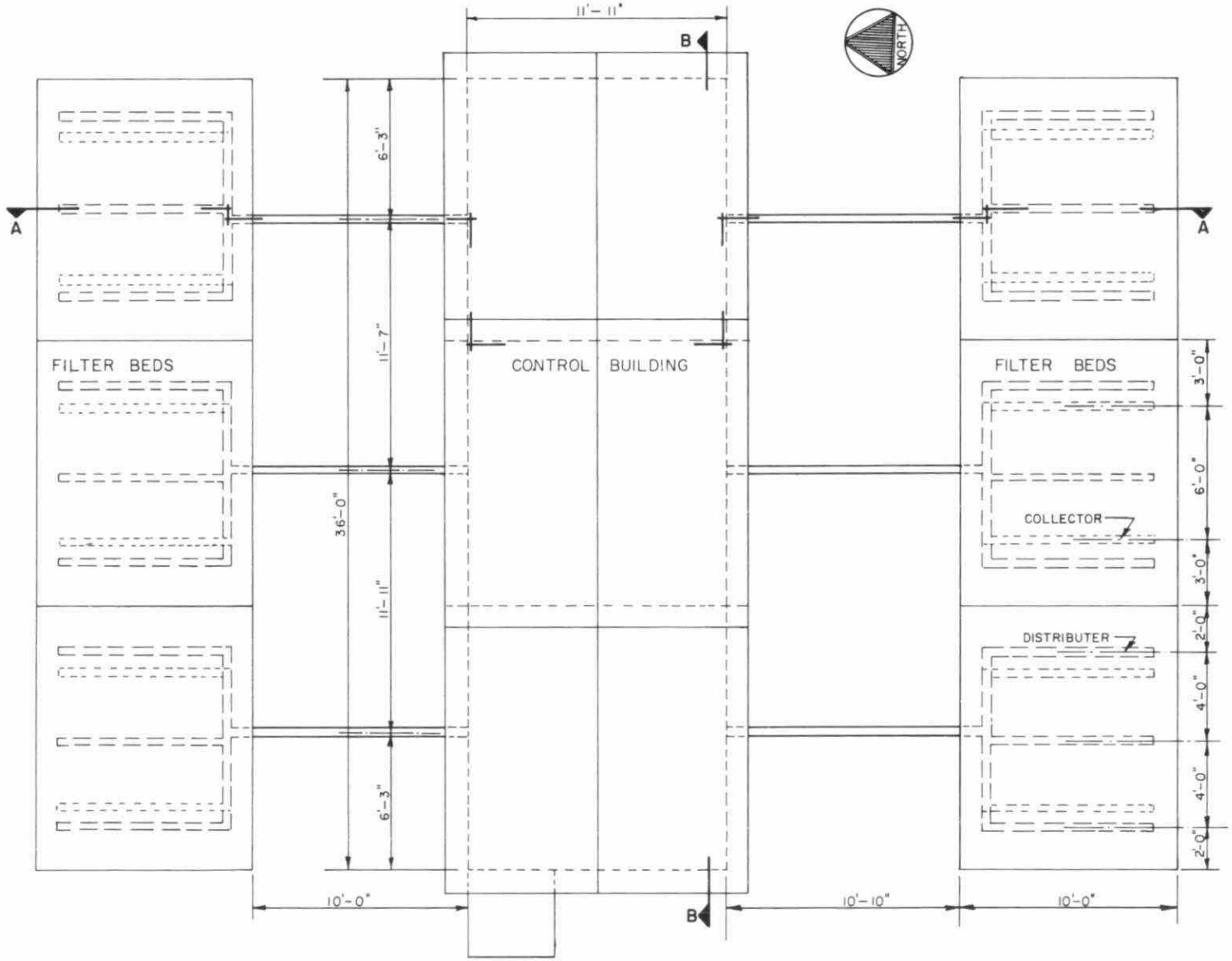
MINISTRY OF THE ENVIRONMENT
PRIVATE WASTE & WATER MANAGEMENT BRANCH
WHITBY EXPERIMENTAL STATION UNDERDRAINED FILTERS
DIAGRAM OF SECTION OF FILTER BED No. 1 WITH MIXED SAND AND RED MUD
JULY 1972 | DWG. No. 1

Scale 3/4"= 1'-0"

APPENDIX II

LOCATION AND DETAILS OF PILOT PLANT


MINISTRY OF THE ENVIRONMENT
PRIVATE WASTE AND WATER MANAGEMENT BRANCH
WHITBY EXPERIMENTAL STATION
UNDERDRAINED FILTERS
GENERAL PLAN
JULY, 1972
FIG. 1
N
TO AJAX
VICTORIA ROAD W.
64'
42'
36'
HOUSE No. 8
407'-6"
EXPERIMENTAL STATION CONTROL BUILDING (See FIG. 3 and FIG. 4
58'
FILTER BEDS
FILTER BEDS
2½" PUMPING LINE
3½" GRAVITY LINE
TILE FIELD
93'
W.C.
HOUSE No. 1
HOUSE No. 2
HOUSE No. 3
HOUSE No. 4
HOUSE No. 5
HOUSE No. 6
HOUSE No. 7
23'
37'
38'
75'
31'
176'
56'-6"
99'-6"
45'-6"
100'
49'-9"
53'-6"
35'-6"
24'-3"
169'-6"
2 COMPARTMENT SEPTIC TANK & PUMP CHAMBER
5½"
7'-6"
M.H.1
M.H.2
M.H.3
M.H.4
M.H.5
M.H.6
6"
DISTRIBUTION CHAMBER
TO ONTARIO HOSPITAL
HOSPITAL ROAD
FARM ROAD
TO WHITBY & HWY. 401
NOTE:
NOT TO SCALE



2 0 2 4 6 8
SCALE IN FEET

MINISTRY OF THE ENVIRONMENT	
PRIVATE WASTE AND WATER MANAGEMENT BRANCH	
WHITBY EXPERIMENTAL STATION UNDERDRAINED FILTERS	
PLAN OF TREATMENT PLANT	
JULY, 1972	FIG. 2

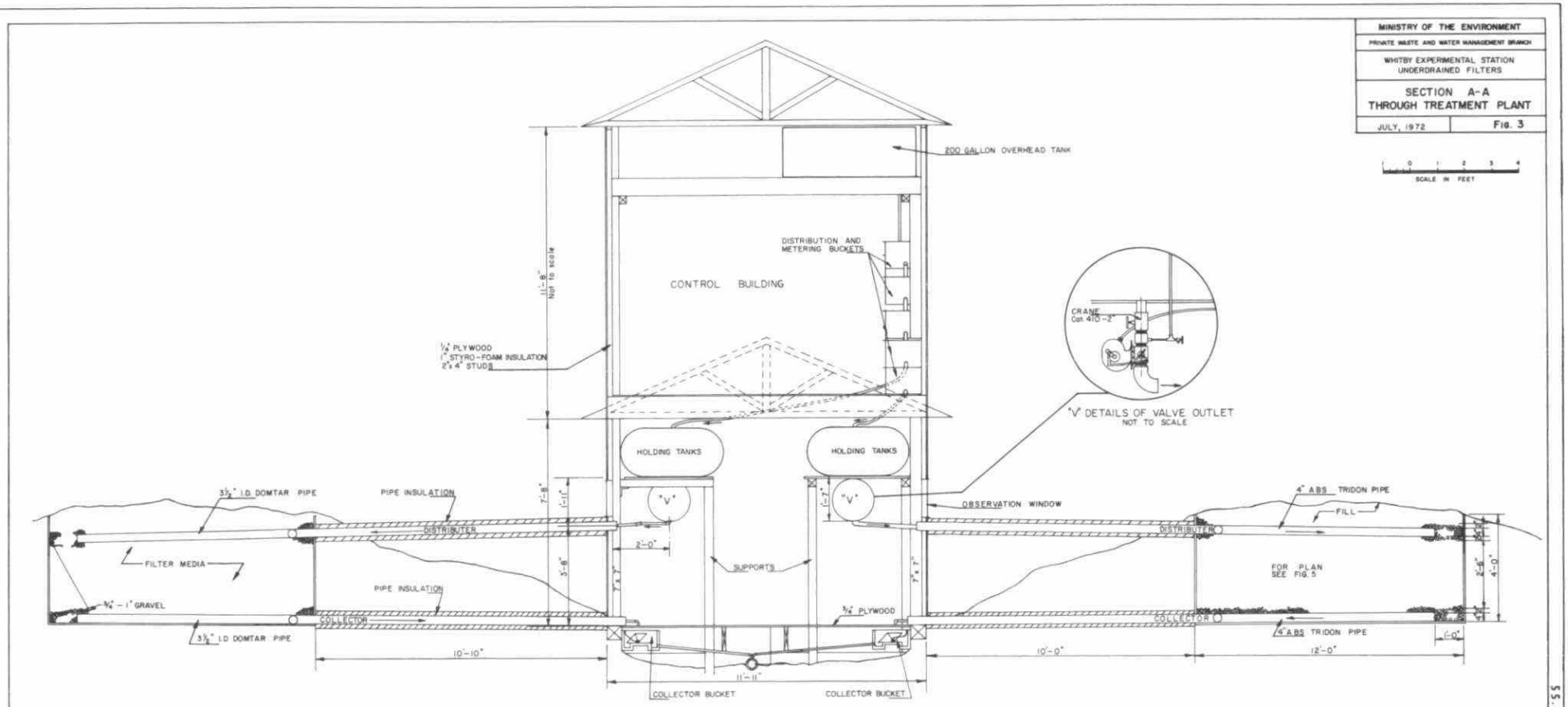
MINISTRY OF THE ENVIRONMENT

PRIVATE WASTE AND WATER MANAGEMENT BRANCH

WHITBY EXPERIMENTAL STATION
UNDERDRAINED FILTERS

SECTION A-A
THROUGH TREATMENT PLANT

JULY, 1972 | FIG. 3



55.

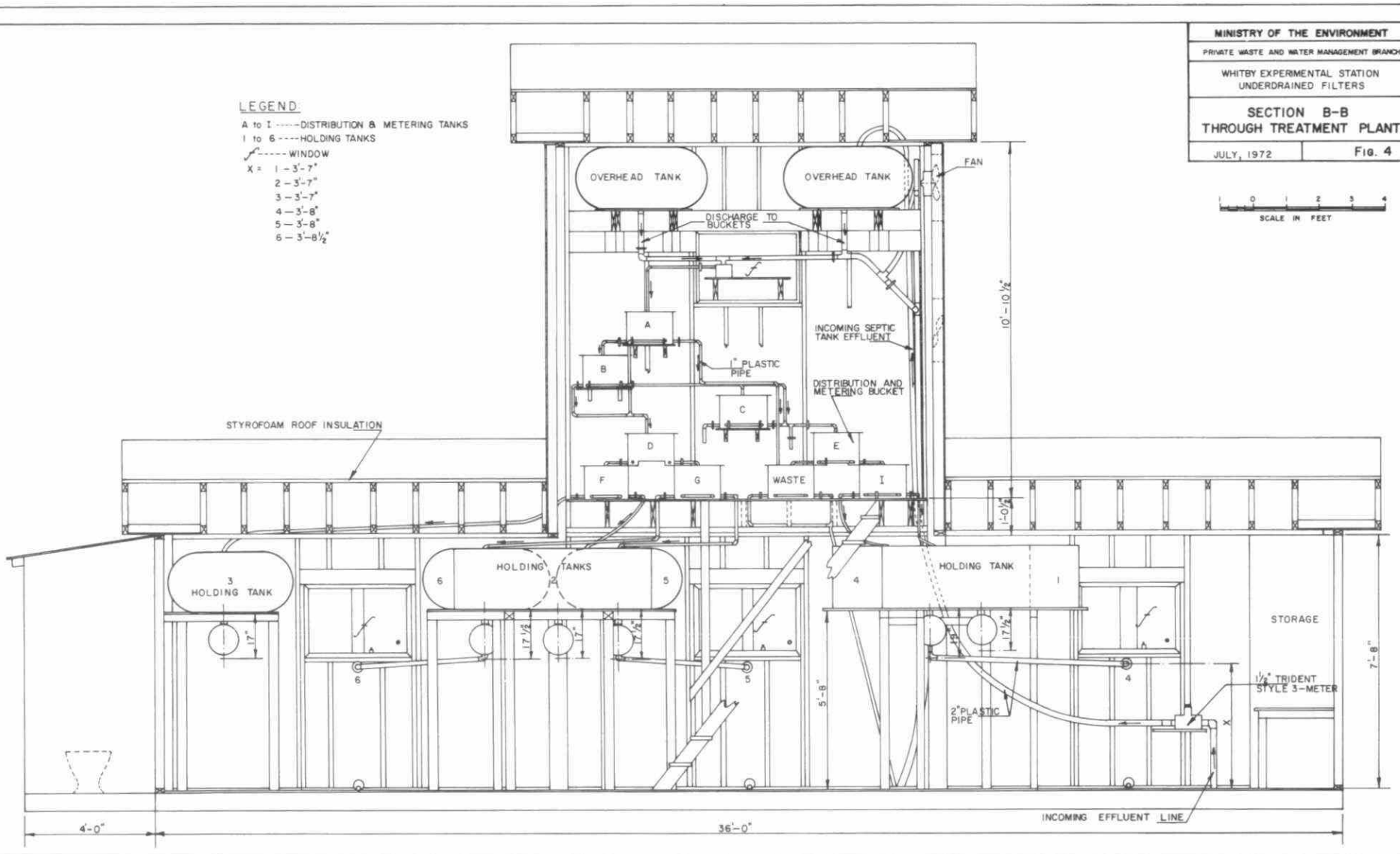
MINISTRY OF THE ENVIRONMENT

PRIVATE WASTE AND WATER MANAGEMENT BRANCH

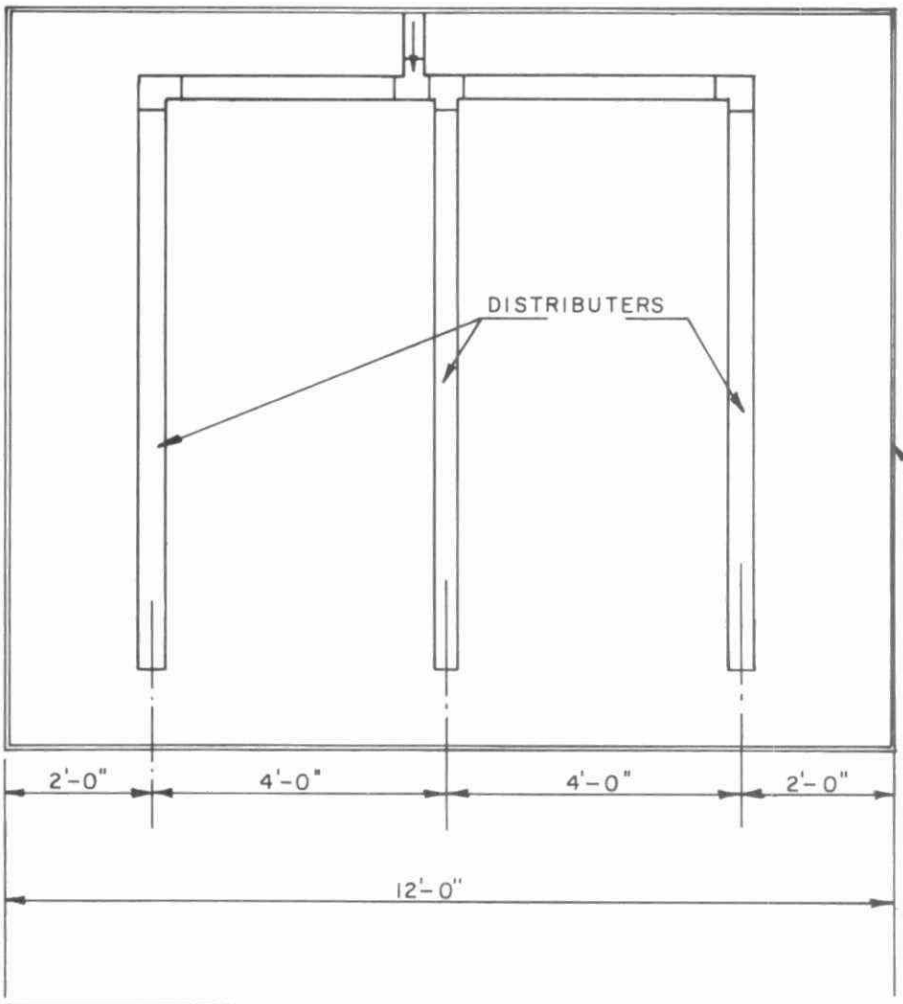
WHITBY EXPERIMENTAL STATION
UNDERDRAINED FILTERS

SECTION B-B
THROUGH TREATMENT PLANT

JULY, 1972 | FIG. 4



'95

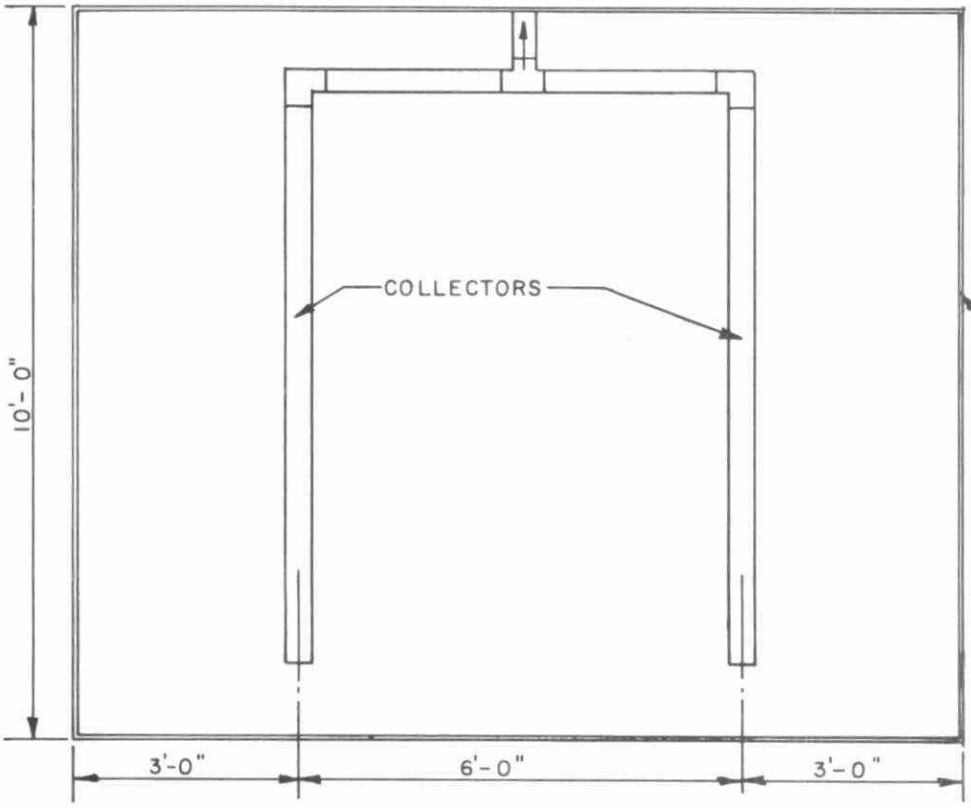


TYPICAL DISTRIBUTER LAYOUT

NOTE:

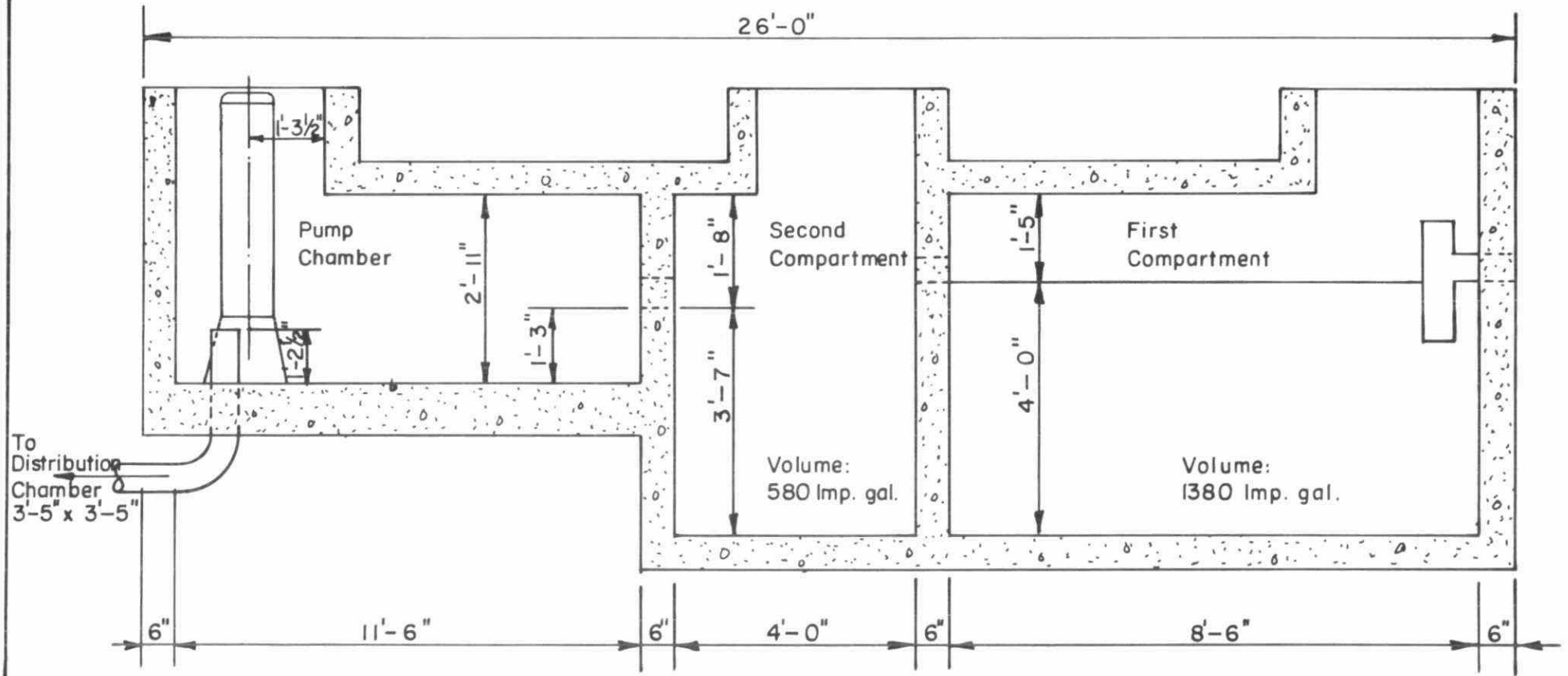
NORTH SIDE — All pipes 4" ABS Tridon, (perforated pipe inside the beds).

SOUTH SIDE — All pipes 3 1/2" Domtar, (perforated pipe inside the beds).



TYPICAL COLLECTOR LAYOUT

MINISTRY OF THE ENVIRONMENT	
PRIVATE WASTE AND WATER MANAGEMENT BRANCH	
WHITBY EXPERIMENTAL STATION UNDERDRAINED FILTERS	
DISTRIBUTER AND COLLECTOR LAYOUT PLAN	
JULY, 1972	FIG. 5



Tank width = 6'-6"

MINISTRY OF THE ENVIRONMENT

PRIVATE WASTE & WATER MANAGEMENT BRANCH

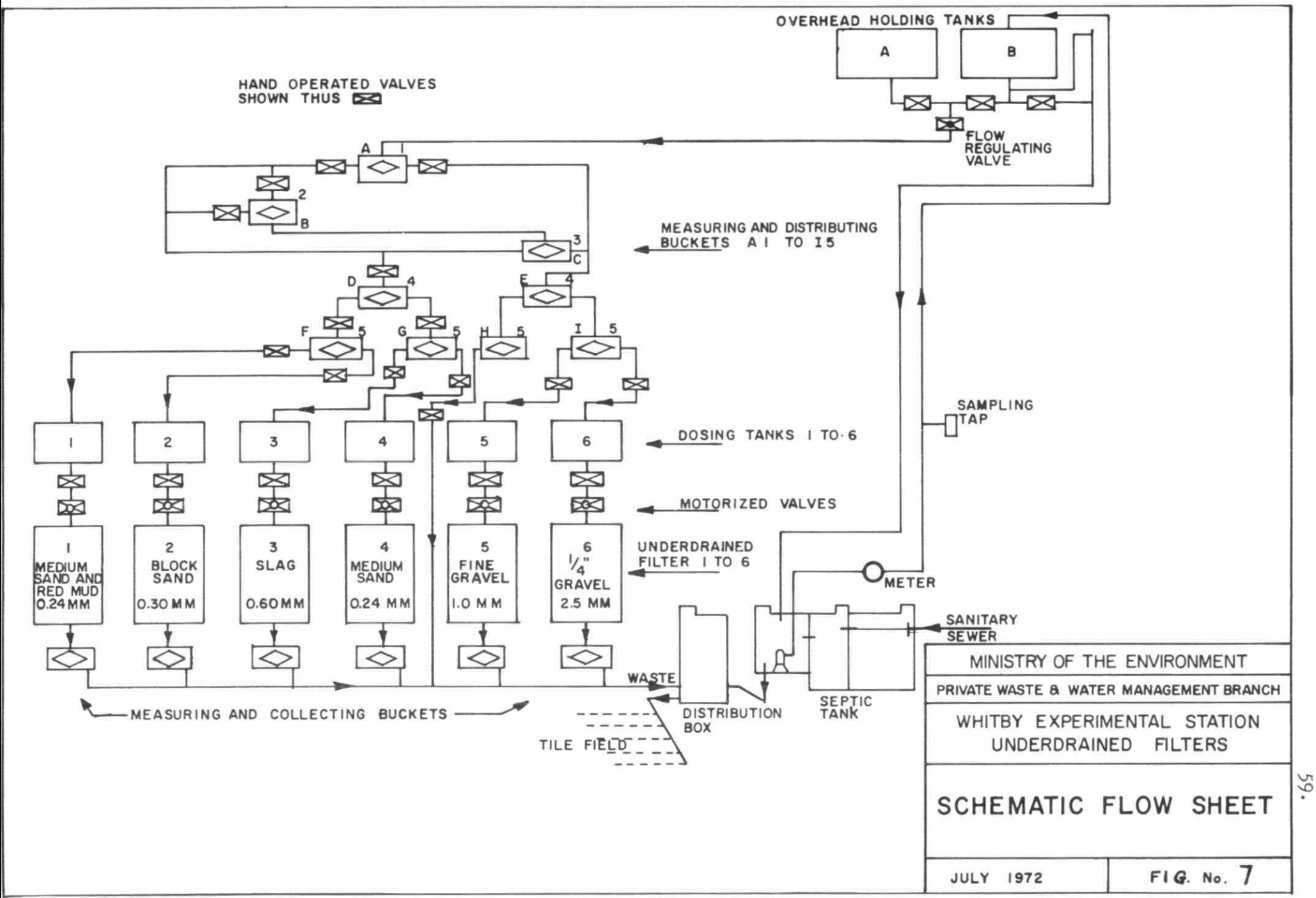
WHITBY EXPERIMENTAL STATION
UNDERDRAINED FILTERS

SEPTIC TANK ELEVATION

Scale 3/8" = 1'-0"

JULY 1972

FIG. No. 6


OVERHEAD HOLDING TANKS
A
B
HAND OPERATED VALVES
SHOWN THUS
FLOW
REGULATING
VALVE
MEASURING AND DISTRIBUTING
BUCKETS A I TO I 5
SAMPLING
TAP
DOSING TANKS I TO 6
MOTORIZED VALVES
UNDERDRAINED
FILTER I TO 6
METER
SANITARY
SEWER
1
MEDIUM SAND AND RED MUD 0.24 MM
2
BLOCK SAND 0.30 MM
3
SLAG 0.60 MM
4
MEDIUM SAND 0.24 MM
5
FINE GRAVEL 1.0 MM
6
1/4" GRAVEL 2.5 MM
WASTE
MEASURING AND COLLECTING BUCKETS
DISTRIBUTION
BOX
SEPTIC
TANK
TILE FIELD
MINISTRY OF THE ENVIRONMENT
PRIVATE WASTE & WATER MANAGEMENT BRANCH
WHITBY EXPERIMENTAL STATION
UNDERDRAINED FILTERS
SCHEMATIC FLOW SHEET
JULY 1972
FIG. No. 7